

OBSERVATIONS
ON THE
SALIVA.
DURING THE ACTION OF
MERCURY UPON THE SYSTEM.
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IN some experiments which I performed, many years ago, on the chemical constitution of the saliva, I announced the existence of two animal substances in this fluid; one of them, nearly, if not altogether, similar to albumen in its coagulated state, and the other resembling the uncoagulable matter of the serosity of the blood. The first of these substances is characterized by being united to a considerable quantity of water, yet insoluble in this fluid, not coagulated by heat, nor precipitated by the various chemical re-agents which act upon liquid albumen, but affected by nitric acid and by potash in the same manner with albumen when coagulated. The other animal ingredient in saliva is characterized by its not being acted upon by the various substances which coagulate or precipi-

tate albumen, while it is precipitated by sub-acetate of lead, and by certain salts of tin and of silver *. This view of the nature of saliva I consider as being confirmed by many of my subsequent experiments in its more important parts, and, what is of still more consequence, it is sanctioned by the high authority of Berzelius, whose analysis may be considered as essentially coinciding with mine †.

An opportunity having occurred of examining the state of the saliva while the system was under the influence of a violent mercurial action, it appeared desirable to ascertain how far the secretion was altered in its chemical properties. The quantity of fluid discharged was supposed to be about two quarts in the day, and all the other effects of the medicine, both local and constitutional, were proportionably severe.

The saliva was of a light brown colour, and had a faint odour; although slightly opaque, it was nearly homogeneous; by standing for twenty-four hours some small films and minute flakes subsided from it, by which its opacity was diminished; in this state it was made the subject of experiment. It was considerably adhesive, but only in a slight degree tenacious; it was easily transferred from one vessel to another in the form of drops, and, when

* Edin. Med. Journ. Vol. II. p. 43, 1806; also Med. Chir. Trans. Vol. IV. p. 76.

† Med. Chir. Trans. Vol. III. p. 246. and seq.

added to water, immediately diffused itself through the fluid, and was completely incorporated with, and apparently dissolved by it. It did not indicate either acid or alkaline properties by the appropriate tests. By slow evaporation, until the residuum had acquired a degree of brittleness, and a brownish yellow colour, the quantity of solid contents appeared to be about one-fiftieth of the weight of the whole fluid.

By being exposed for some time to the heat of boiling water, a degree of coagulation was produced; the fluid became considerably more opaque and thicker in its consistence, but there was no precipitate or separation of any of the solid matter. It was submitted to the following tests:—solution of corrosive muriate of mercury produced a considerable precipitate, and, when the mixture was subjected to the heat of boiling water, a number of dense flakes separated from it, leaving the fluid transparent; after being passed through a filter, it had the aspect of pure water. By the addition of muriatic acid, the opacity of the saliva was considerably increased, and by applying heat, a coagulum was formed which gradually subsided, but it was less firm, and the separation was less complete than when corrosive muriate of mercury had been employed.

From these experiments we learn that the chemical constitution of the saliva was considerably

different from its natural state, and that this difference consisted in its containing a quantity of animal matter, possessing properties similar to those of albumen in its uncoagulated state, or as it exists in the serum of the blood.

Having ascertained this change in the nature of the animal matter in this saliva, which, it may be presumed, was owing to the action of mercury upon the system, it became an interesting object of inquiry to ascertain whether any mercury could be detected in it. The method which I employed for this purpose was to treat the evaporated residuum with nitric acid, by which means any mercury, if present, would be converted into the nitrate, and to test the fluid by the proto-muriate of tin. A preliminary experiment was made in order to learn how small a proportion of mercury might be detected by this process. A given quantity of mercury was converted into the nitrate; I took as much of this nitrate as contained one grain of mercury; this was successively diffused through different proportions of water, until it at length composed no more than $\frac{1}{10000}$ of the mixture, when I found that the proto-muriate of tin produced a grey cloud, which was very distinctly visible. The same process was adopted with respect to the evaporated residuum of the saliva, but it did not afford the least indication of the presence of mercury; the experiment was repeated more than once without effect, and I may remark that I obtained the same results in

some experiments of a similar kind, which were performed several years ago.

After an interval of sixteen days I procured from the same individual a second portion of saliva, the use of mercury had, in the mean time, been omitted; and although the quantity of fluid discharged was still considerable, it was much less than before. The sensible qualities of the fluid were now entirely changed: it was considerably opake, and had a number of mucilaginous flakes floating in it, which were insoluble in water, and not easily miscible with it; it was so viscid as to be capable of being drawn into threads, while, on the contrary, it did not admit of being dropped. Its solid contents, as ascertained by careful evaporation, were found to be considerably more in quantity than in the former case; it slightly reddened litmus paper, indicating the presence of an uncombined acid.

When this saliva was submitted to the temperature of boiling water it was rendered more opake, but no proper coagulation took place; after standing for forty-eight hours, there was a separation of a more dense substance from the remainder of the fluid, but in an imperfect degree only. The corrosive muriate of mercury and muriatic acid were respectively added to portions of the saliva; in each case the fluid was rendered more opake, but no distinct coagulation was produced, and although the

effect was increased by applying heat, still the separation was not complete. By the addition of the sub-acetate of lead, a very copious precipitate was thrown down, consisting partly of large flakes, while the fluid was left quite transparent, and, as it appeared, deprived of all the animal impregnation. This saliva was examined as the former had been, for the purpose of discovering whether it contained any mercury, and it is scarcely necessary to state that the search was unsuccessful*.

The conclusions which we may draw from the above experiments, on the nature of the saliva discharged while the system is affected by the action of mercury, are sufficiently remarkable to arrest our attention. We learn from them, in the first place, that no portion of the mercury is actu-

* The improved state of medicine, with respect to the administration of mercury, seldom affords us an opportunity of observing so violent an operation of the medicine as took place in the above case, but I found the same kind of change, although in a less degree, in the saliva of persons under the moderate influence of this medicine. In a specimen which I procured from the wards of Guy's hospital, the saliva had nearly lost its tenacity, was readily soluble in water, and after being passed through a filter, was precipitated by corrosive muriate of mercury, and was rendered partially opaque by heat. In another specimen the same effects were observable, but here the fluid retained a degree of tenacity, and was only in part capable of being passed through a filter, while a third specimen appeared to be little changed from its healthy state, except in its containing a greater proportion of water. I shall not omit any opportunity which occurs of examining the saliva in the state of more severe mercurial action.

ally present in the fluid, from which it follows that the effect of this medicine, although so remarkably manifested upon the salivary glands, must be produced through the medium of the system generally, and hence we may presume that all the organs destined for the secretion of mucus will undergo the same change. This change would appear to consist essentially in the conversion of the animal matter, from the state of a mucous to that of a serous, or rather of an albuminous fluid.

Now, although we are not sufficiently acquainted with the theory of secretion to know what are the minute operations which enable the capillary vessels connected with the glands to produce their appropriate fluids, yet we may form some idea of the relation which they bear to each other, as far, at least, as regards the greater or less complexity of the process. All those fluids, for example, which proceed from what are termed serous membranes, appear to differ from the serum of the blood solely in the proportion of albumen which they contain, and we may therefore conceive that they are generated by a process resembling transudation, and that this is, in a great measure, of a mechanical nature. In the secretions, however, which are discharged from the mucous surfaces we find a change effected which is of a chemical nature, where a new substance is generated, which did not previously exist in the blood. In what way the vital functions act, so as to convert albumen into the muc-

luginous matter which forms the basis of saliva is at present beyond our power to ascertain, but whatever it be, we find that in the case before us, the operation of mercury upon these parts is to counteract the ordinary secreting process, and to reduce the action of the glands to that of mere transudation.

Were we disposed to speculate upon this subject we might inquire, whether an increase in the diameter of the vessels, in consequence of an increased afflux of fluids to them, or whether the more rapid transmission of their contents, without an increase in the capacity of the vessels, would be adequate to explain the effect. But I think the present state of our knowledge on the subject is much too imperfect to enable us to arrive at any degree of certainty upon these topics. Nor is it in our power to make any considerable advance in the application to the facts to pathology, but still we may be allowed to state some probable deductions from them, which may perhaps lead to new facts, and these in their turn to more important conclusions.

As we find that at least one operation of mercury is to convert a mucous into a serous secretion, the following queries suggest themselves; whether we may not conceive that the action of this remedy, in the cure of glandular obstructions, consists simply in producing this change in the

nature of the secretion? Whether, even in the removal of the diseases of surfaces, mercury may not operate upon the same principle, by counteracting the effect of specific secretions, and reducing them to the mere transudation of a serous fluid? Whether by examining the effects of the remedy upon the chemical nature of the mucous secretions, we may not be furnished with a more accurate test of its constitutional action, or at least of the extent of this action, than we at present possess in the mere quantity of saliva that is discharged?

Before I conclude this paper, I may remark that I had an opportunity, some time ago, of examining the fluid discharged from the internal surface of the stomach in two cases where this organ exhibited the appearance of acute inflammation. In one there was reason to suppose that death had been occasioned by arsenic, although none could be detected; in the other the patient died in a few hours after swallowing a large quantity of ardent spirits. In both these instances the secretion from the mucous membrane of the stomach appeared to be much more albuminous, or serous, than in its natural state.

It is well known that there are certain morbid conditions of the urine, in which it is found to contain a portion of albumen, cognizable by the usual tests, and it is generally understood to be an

indication of an inflammatory action of the sanguiferous system. I would not venture to generalize so far as to conclude, that the action of mercury on the salivary glands, the inflammation of the mucous membrane of the stomach, and the peculiar condition of the system producing albuminous urine, are all to be referred to the same specific action, but the coincidence is noticed as one that may deserve further investigation.

As an appendix to the above paper, I shall beg leave to lay before the Society an examination which I lately made of the mucus expectorated by a patient suffering under a severe catarrhal affection. I am aware, that a part at least of this fluid proceeded from the glands of the lungs, whereas the saliva, in the former case, may be supposed to have been principally discharged from the salivary glands, but I am of opinion that all the mucous secretions resemble each other in their more essential properties, so as to admit of a comparison being made between them in their various morbid states. In the following case it will appear that the saliva had experienced no very important change in its chemical constitution, but that the quantity of the substance which may be considered as its specific ingredient (and which I regard as nearly resembling coagulated albumen), was much increased in quantity, while there was no tendency

to that alteration in its nature which appears to be produced by mercurial action.

A patient who was suffering under a severe catarrhal cough, but not attended with inflammation, expectorated a large quantity of unusually thick mucus, probably not less than a pint in 24 hours. A portion of this fluid was obtained for examination. It was extremely tenacious, so as to be capable of being drawn into very long threads, and in attempting to pour it from one vessel to another, the whole of it passed over at once. It was semi-opake, and the greater part of it of a uniform consistence, but there were certain portions which were more opake than the rest, and remained suspended in the other part of the fluid. There was a great quantity of air-bubbles attached to its upper surface, and the froth remained for several days without any apparent diminution. The most delicate tests did not indicate the slightest tendency either to acid or alkali, and it continued exposed to the air for three weeks without experiencing any change. Although its consistence appeared to be at least as dense as the white of an egg, it was found to contain a much smaller quantity of solid contents. When carefully evaporated by a gentle heat, until it was just beginning to be charred, but while it was still capable of being mixed with water, and of regaining its former consistence, a residuum of about $\frac{1}{50}$ was obtained.

This had the appearance of a hard, brittle, semi-transparent substance, and did not appear to undergo any change by exposure to the air. When the heat was continued, the residuum was converted into a brown mass, emitting a specific odour, and slightly attracting moisture from the atmosphere. A red heat converted it into a hard spongy charcoal, which was difficult to incinerate. When exposed to a bright red heat it was consumed, leaving a white substance which appeared to undergo a partial fusion, attended with decrepitation. A white powder remained which was found to be chiefly muriate of soda.

A portion of the mucus had four parts of water added to it, and was suffered to remain at rest. After an interval of three days the mucus continued floating in the water, apparently without having mixed itself with it. The whole was then thrown upon a paper filter. A quantity of fluid, that was perfectly transparent and only slightly viscid (A) passed through, while the mucus remained on the filter apparently little changed. Another similar mixture was strongly agitated; the greatest part of the mucus appeared to be thereby uniformly diffused through the water, but there were masses of films or threads suspended in it, which seemed incapable of being incorporated with the water. The whole fluid was very viscid and tenacious, and the mucus showed no tendency to separate or subside from the water.

A portion of the mucus was exposed for some time to the boiling temperature; there was little immediate effect produced; but after some time the opake masses became more dense and gradually subsided, while the fluid generally was rendered rather more opake. In twenty-four hours a small quantity of a white precipitate subsided from it, and it was now considerably less tenacious, so as to be capable of being transferred in divided portions from one vessel to another, but it was still very viscid, and frothed much upon agitation (B). The solution of the corrosive muriate of mercury had no effect upon it at the temperature of the atmosphere; by heat it was rendered rather more opake, but no precipitate or coagulum was formed.

Two equal portions of the mucus had the solution of the corrosive muriate of mercury, and the muriate of tin respectively added to them; no immediate effect was produced, nor was there any very considerable change in twenty-four hours. They were then exposed for some time to the temperature of boiling water, when, as in the former cases, the opake parts were rendered more dense, and slowly subsided, while, after a second interval of twenty-four hours, the whole of the two fluids became considerably less tenacious, and large flocculent masses were formed, which slowly subsided; this was more especially the case with the fluid to which the corrosive muriate of mercury had been added.

When nitric acid was added to the mucus, without the action of heat, a white precipitate was gradually thrown down in small quantity; and when heat was applied, the precipitate was increased and rendered more dense. The fluid acquired a light yellow colour, and a very decided waxy, or rather adipocerous odour. When the acid was supersaturated with ammonia, the colour was converted to a deep yellow, but no precipitate was thrown down. The precipitate mentioned above, being separated by a filter, was of a straw colour, somewhat fusible, and inflammable, and appeared to be of a waxy or adipocerous nature. A portion of the mucus was evaporated to dryness, and was then heated with nitric acid. This dissolved it, with the disengagement of gas, while the fluid acquired the straw colour and adipocerous odour. By the addition of ammonia its colour was much deepened, and a white precipitate was thrown down.

To a portion of the filtered fluid (A) acetate of lead was added, and immediately a copious white precipitate was deposited, which, after remaining at rest for twenty-four hours, separated into two portions, the lower having the appearance of small dense white particles, the upper more bulky, less white, and flocculent. Another portion of the fluid (A) was slowly evaporated, and it left a residuum, which was obviously composed, partly of a film of animal matter, and partly of a saline substance, in the form of irregular and indistinct crystals.

To a portion of the entire mucus, after having been agitated with four parts of water, the acetate of lead was added. A very copious precipitate was thrown down, which, as in the former case, consisted distinctly of two portions, a more dense one below, and a more flocculent one above; the fluid was left completely limpid and transparent. The muriate of tin and the nitrate of silver had both of them the effect of gradually throwing down precipitates from the mucus, which, in the latter case, were of a dark brown colour, while the fluid was rendered transparent and much less tenacious.

*Upper Bedford Place,
April 24, 1824.*